LB11867FV

Variable Speed
Single-phase Full-wave
Pre-driver for Fan Motor

Monolithic Digital IC

Overview
LB11867FV is a single-phase bipolar driving motor pre-driver with the variable speed function compatible with external PWM signal. With a few external parts, a highly-efficient and highly-silent variable drive fan motor with low power consumption can be achieved. This product is best suited for driving of the server requiring large air flow and large current and the fan motor of consumer appliances.

Features
• Single-phase Full-wave Driving Pre-driver
  ⇒ Low-saturation Drive Using External PMOS–NMOS Enables
  High-efficiency Low Power-consumption Drive
• Variable Speed Control Possible with External PWM Input
  ⇒ Separately-excited Upper Direct PWM (f =30 kHz) Control
    Method Ensures Highly Silent Speed Control
• Current Limiting Circuit Incorporated
  ⇒ Chopper Type Current Limiting Made at Startup and during Lock
• Reactive Current Cut Circuit Incorporated
  ⇒ Reactive Current before Phase Changeover is Cut, Ensuring
  Highly Silent and Low Power-consumption Drive
• Minimum Speed Setting Pin
  ⇒ Minimum Speed can be Set by Setting the Resistance
• Soft Start Setting Pin
• Lock Protection and Automatic Reset Circuits Incorporated
• FG (Rotation Speed Detection) Output
• Thermal Shutdown Circuit Incorporated

Typical Applications
• Computing & Peripherals
• Industrial
• Server
• Vending Machine

ORDERING INFORMATION
See detailed ordering and shipping information on page 9 of this data sheet.
## SPECIFICATIONS

### ABSOLUTE MAXIMUM RATINGS \((T_A = 25^\circ{C})\)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Ratings</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>(V_{\text{CC}}) max</td>
<td>(V_{\text{CC}}) Pin Maximum Supply Voltage</td>
<td></td>
<td>18</td>
<td>V</td>
</tr>
<tr>
<td>(I_{\text{OUTN}}) max</td>
<td>(OUTN) Pin Maximum Output Current</td>
<td></td>
<td>20</td>
<td>mA</td>
</tr>
<tr>
<td>(I_{\text{OUTP}}) max</td>
<td>(OUTP) Pin Maximum Sink Current</td>
<td></td>
<td>20</td>
<td>mA</td>
</tr>
<tr>
<td>(V_{\text{OUT}}) max</td>
<td>(OUT) Pin Output Withstand Voltage</td>
<td></td>
<td>18</td>
<td>V</td>
</tr>
<tr>
<td>(V_{\text{VTH}}, \text{VRMI}) max</td>
<td>(V_{\text{TH}}, \text{RMI}) Pins Withstand Voltage</td>
<td></td>
<td>7</td>
<td>V</td>
</tr>
<tr>
<td>(V_{\text{S-S}}) max</td>
<td>(S-S) Pin Withstand Voltage</td>
<td></td>
<td>7</td>
<td>V</td>
</tr>
<tr>
<td>(V_{\text{FG}}) max</td>
<td>(FG) Output Pin Withstand Voltage</td>
<td></td>
<td>19</td>
<td>V</td>
</tr>
<tr>
<td>(I_{\text{FG}}) max</td>
<td>(FG) Pin Maximum Output Current</td>
<td></td>
<td>10</td>
<td>mA</td>
</tr>
<tr>
<td>(I_{\text{SVREG}}) max</td>
<td>(5\text{VREG}) Pin Maximum Output Current</td>
<td></td>
<td>20</td>
<td>mA</td>
</tr>
<tr>
<td>(P_d) max</td>
<td>Allowable Power Dissipation</td>
<td>With specified substrate (Note 1)</td>
<td>800</td>
<td>mW</td>
</tr>
<tr>
<td>(T_{\text{opr}})</td>
<td>Operating Temperature</td>
<td>(Note 2)</td>
<td>−30 to 95</td>
<td>°C</td>
</tr>
<tr>
<td>(T_{\text{stg}})</td>
<td>Storage Temperature</td>
<td></td>
<td>−55 to 150</td>
<td>°C</td>
</tr>
</tbody>
</table>

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. Specified substrate: 114.3 mm × 76.1 mm × 1.6 mm, glass epoxy board.
2. \(T_j\) max = 150°C must not be exceeded.

### RECOMMENDED OPERATING CONDITIONS \((T_A = 25^\circ{C})\)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Ratings</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>(V_{\text{CC}})</td>
<td>(V_{\text{CC}}) Supply Voltage</td>
<td>5.5 to 16</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>(V_{\text{TH}}, \text{RMI})</td>
<td>(V_{\text{TH}}, \text{RMI}) Input Voltage Range</td>
<td>0 to 5</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>(V_{\text{ICM}})</td>
<td>Hall Input Common-phase Input Voltage Range</td>
<td>0.2 to 3</td>
<td>V</td>
<td></td>
</tr>
</tbody>
</table>

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

### ELECTRICAL CHARACTERISTICS \((T_A = 25^\circ{C}, V_{\text{CC}} = 12\text{ V})\)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>(I_{\text{CC1}})</td>
<td>Circuit Current</td>
<td>During drive</td>
<td>5.5</td>
<td>7.5</td>
<td>9.5</td>
<td>mA</td>
</tr>
<tr>
<td>(I_{\text{CC2}})</td>
<td></td>
<td>During lock protection</td>
<td>5.5</td>
<td>7.5</td>
<td>9.5</td>
<td>mA</td>
</tr>
<tr>
<td>5VREG</td>
<td>5VREG Voltage</td>
<td>(I_{\text{SVREG}} = 5\text{ mA})</td>
<td>4.80</td>
<td>4.95</td>
<td>5.10</td>
<td>V</td>
</tr>
<tr>
<td>(V_{\text{LIM}})</td>
<td>Current Limiting Voltage</td>
<td></td>
<td>185</td>
<td>200</td>
<td>215</td>
<td>mV</td>
</tr>
<tr>
<td>(V_{\text{CPWMH}})</td>
<td>CPWM Pin “H” Level Voltage</td>
<td></td>
<td>2.8</td>
<td>3.0</td>
<td>3.2</td>
<td>V</td>
</tr>
<tr>
<td>(V_{\text{CPWML}})</td>
<td>CPWM Pin “L” Level Voltage</td>
<td></td>
<td>0.9</td>
<td>1.1</td>
<td>1.3</td>
<td>V</td>
</tr>
<tr>
<td>(I_{\text{CPWM1}})</td>
<td>CPWM Pin Charge Current</td>
<td>(V_{\text{CPWM}} = 0.5\text{ V})</td>
<td>24</td>
<td>30</td>
<td>36</td>
<td>μA</td>
</tr>
<tr>
<td>(I_{\text{CPWM2}})</td>
<td>CPWM Pin Discharge Current</td>
<td>(V_{\text{CPWM}} = 3.5\text{ V})</td>
<td>21</td>
<td>27</td>
<td>33</td>
<td>μA</td>
</tr>
<tr>
<td>FPWMM</td>
<td>CPWM Oscillation Frequency</td>
<td>(C = 220\text{ pF})</td>
<td>–</td>
<td>30</td>
<td>–</td>
<td>kHz</td>
</tr>
<tr>
<td>(V_{\text{CTH}})</td>
<td>CT Pin “H” Level Voltage</td>
<td></td>
<td>2.8</td>
<td>3.0</td>
<td>3.2</td>
<td>V</td>
</tr>
<tr>
<td>(V_{\text{CTL}})</td>
<td>CT Pin “L” Level Voltage</td>
<td></td>
<td>0.9</td>
<td>1.1</td>
<td>1.3</td>
<td>V</td>
</tr>
<tr>
<td>(I_{\text{CT1}})</td>
<td>CT Pin Charge Current</td>
<td>(V_{\text{CT}} = 0.5\text{ V})</td>
<td>1.6</td>
<td>2.0</td>
<td>2.5</td>
<td>μA</td>
</tr>
<tr>
<td>(I_{\text{CT2}})</td>
<td>CT Pin Discharge Current</td>
<td>(V_{\text{CT}} = 3.5\text{ V})</td>
<td>0.16</td>
<td>0.20</td>
<td>0.25</td>
<td>μA</td>
</tr>
<tr>
<td>(R_{\text{CT}})</td>
<td>CT Pin Charge/Discharge Ratio</td>
<td></td>
<td>8</td>
<td>10</td>
<td>12</td>
<td>times</td>
</tr>
<tr>
<td>(I_{\text{S-S}})</td>
<td>S-S Pin Discharge Current</td>
<td>(V_{\text{S-S}} = 1\text{ V})</td>
<td>0.4</td>
<td>0.5</td>
<td>0.6</td>
<td>μA</td>
</tr>
</tbody>
</table>
### ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ C, V_{CC} = 12\, V$) (continued)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{ONH}$</td>
<td>OUTN Output H-level Voltage</td>
<td>$I_O = 10, mA$</td>
<td>$V_{CC} - 0.85$</td>
<td>$V_{CC} - 1.00$</td>
<td>$V$</td>
<td></td>
</tr>
<tr>
<td>$V_{ONL}$</td>
<td>OUTN Output L-level Voltage</td>
<td>$I_O = 10, mA$</td>
<td>$-0.9$</td>
<td>$1.00$</td>
<td>$V$</td>
<td></td>
</tr>
<tr>
<td>$V_{ONP}$</td>
<td>OUTP Output L-level Voltage</td>
<td>$I_O = 10, mA$</td>
<td>$-0.5$</td>
<td>$0.65$</td>
<td>$V$</td>
<td></td>
</tr>
<tr>
<td>$V_{HIN}$</td>
<td>Hall Input Sensitivity</td>
<td>$I_{IN^+}, I_{IN^-}$ differential voltage (including offset and hysteresis)</td>
<td>$-\pm10$</td>
<td>$\pm20$</td>
<td>$mV$</td>
<td></td>
</tr>
<tr>
<td>$V_{FGL}$</td>
<td>FG Output L-level Voltage</td>
<td>$I_{FG} = 5, mA$</td>
<td>$-0.15$</td>
<td>$0.30$</td>
<td>$V$</td>
<td></td>
</tr>
<tr>
<td>$I_{FGL}$</td>
<td>FG Pin Leakage Current</td>
<td>$V_{FG} = 19, V$</td>
<td>$-20$</td>
<td>$\mu A$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{VTH/IRMI}$</td>
<td>VTH/RMI Pin Bias Current</td>
<td>$CPWM = V_{TH/RMI} = 2, V$</td>
<td>$-0.1$</td>
<td>$\mu A$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

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**Figure 1. $P_d\max - T_A$**

Mounted on a specified board:
114.3 × 76.1 × 1.6 mm glass epoxy board
**Figure 2. Block Diagram**

**TRUTH TABLE – DRIVE LOCK**

<table>
<thead>
<tr>
<th>IN=</th>
<th>IN+</th>
<th>CT</th>
<th>OUT1P</th>
<th>OUT1N</th>
<th>OUT2P</th>
<th>OUT2N</th>
<th>FG</th>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>OFF</td>
<td>H</td>
<td>L</td>
<td>OUT1 → 2 drive</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
<td></td>
<td>OFF</td>
<td>H</td>
<td>L</td>
<td>L</td>
<td>OFF</td>
<td>OUT2 → 1 drive</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
<td>H</td>
<td>OFF</td>
<td>L</td>
<td>OFF</td>
<td>H</td>
<td>L</td>
<td>Lock protection</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
<td></td>
<td>OFF</td>
<td>H</td>
<td>OFF</td>
<td>L</td>
<td>OFF</td>
<td></td>
</tr>
</tbody>
</table>

**TRUTH TABLE – SPEED CONTROL**

<table>
<thead>
<tr>
<th>VTH, RMI</th>
<th>CPWM</th>
<th>IN=</th>
<th>IN+</th>
<th>OUT1P</th>
<th>OUT1N</th>
<th>OUT2P</th>
<th>OUT2N</th>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>H</td>
<td>H</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>OFF</td>
<td>H</td>
<td>OUT1 → 2 drive</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
<td></td>
<td>OFF</td>
<td>H</td>
<td>L</td>
<td>L</td>
<td></td>
<td>OUT2 → 1 drive</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
<td>H</td>
<td>L</td>
<td>OFF</td>
<td>L</td>
<td>OFF</td>
<td>H</td>
<td>Regeneration mode</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
<td></td>
<td>OFF</td>
<td>H</td>
<td>OFF</td>
<td>L</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:** For VTH, RMI, and S-S pins, refer to the timing chart.
*1: Power-GND Wiring  
SGND is connected to the control circuit power supply system.

*2: Power Stabilization Capacitor  
For the power stabilization capacitor on the signal side, use the capacitance of 1 μF or more.  
Connect VCC and GND with a thick and shortest pattern.

*3: Power Stabilization Capacitor on the Power Side  
For the power stabilization capacitor on the power side, use the capacitance of 1 μF or more.  
Connect the power supply on the power side and GND with a thick and shortest pattern.

*4: IN+, IN− Pins  
Hall signal input pin.  
Wiring should be short to prevent carrying of noise.  
If noise is carried, insert the capacitor between IN+ and IN− pins.  
The Hall input circuit functions as a comparator with hysteresis (15 mV).

*5: CPWM Pin  
Pin to connect the capacitor for generation of the PWM basic frequency.  
The use of CP = 220 pF causes oscillation at f = 30 kHz, which is the basic frequency of PWM.  
As this is used also for the current limiting canceling signal, be sure to connect the capacitor even when the speed control is not made.

*6: RMI Pin  
Minimum speed setting pin.  
Perform pull-up with 5VREG when this pin is not to be used.  
If the IC power supply is likely to be turned OFF first when the pin is used with external power supply, be sure to insert the current limiting resistor to prevent inflow of large current.  
The same applies to the VTH pin.

This also has a soft switch section with ±30 mV (input signal differential voltage).  
It is also recommended that the Hall input level is minimum 100 mV(p−p).
*7: VTH Pin
   Speed control pin.
   Connect this pin to GND when it is not used
   (at full speed).
   For the control method, refer to the timing chart.
   For control with pulse input, insert the current
   limiting resistor and use the pin with the frequency
   of 20 kHz to 100 kHz (20 kHz to 50 kHz
   recommended).

*8: SENSE Pin
   Current limiting detection pin.
   When the pin voltage exceeds 0.2 V, the current is
   limited and the operation enters the lower
   regeneration mode.
   Connect this pin to GND when it is not to be used.

*9: FG Pin
   Rotation speed detection pin.
   This is an open collector output, which can detect
   the rotation speed from the FG output according to
   the phase changeover. Keep this pin open when it
   is not to be used.

*10: CT Pin
   Pin to connect the lock detection capacitor.
   The constant-current charge and discharge circuits
   incorporated cause locking when the pin voltage
   becomes 3.0 V and unlocking when it is 1.1 V.
   Connect the pin to GND when it is not to be used
   (locking not necessary).

*11: S–S Pin
   Pin to connect the soft-start setting capacitor.
   Connect the capacitor between 5VREG and S–S
   pin.
   This pin enables setting of the soft start time
   according to the capacity of the capacitor.
   See the timing char.
   Connect the pin to GND when it is not to be used.
CONTROL TIMING CHART (SPEED CONTROL)

1. Minimum Speed Setting (Stop) Mode
   The low-speed fan rotation occurs at the minimum speed set with the RMI pin. When the minimum speed is not set (RMI pin pulled up to 5VREG), the motor stops.

2. Low Speed ⇔ High Speed
   PMW control is made by comparing the CPWM oscillation voltage (1.1 V ⇔ 3.0 V) and VTH voltage.
   Both upper and lower output TRs are turned ON when the VTH voltage is low. The upper output TR is turned OFF when the VTH voltage is high, regenerating the coil current in the lower TR. Therefore, as the VTH voltage decreases, the output ON-DUTY increases, causing increase in the coil current, raising the motor rotation speed.
   The rotation speed can be monitored with the FG output.

3. Full Speed Mode
   The full speed mode becomes effective when the VTH voltage is 1.1 V or less. (Set VTH = GND when the speed control is not to be made)
CONTROL TIMING CHART (SOFT START)

1. At VTH < RMI Voltage

Adjust the S−S pin voltage gradient by means of the capacitance of the capacitor between the S−S pin and 5VREG. Recommended capacitor: 0.1 µF to 1 µF.

2. At VTH > RMI Voltage

Adjust the S−S pin voltage gradient by means of the capacitance of the capacitor between the S−S pin and 5VREG. Recommended capacitor: 0.1 µF to 1 µF.
## ORDERING INFORMATION

<table>
<thead>
<tr>
<th>Device</th>
<th>Package</th>
<th>Wire Bond</th>
<th>Shipping† (Qty / Packing)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LB11867FV–MPB–H</td>
<td>SSOP16 (225mil) (Pb–Free / Halogen Free)</td>
<td>Au–wire</td>
<td>90 / Fan–Fold</td>
</tr>
<tr>
<td>LB11867FV–TLM–E</td>
<td>SSOP16 (225mil) (Pb–Free)</td>
<td>Au–wire</td>
<td>2,000 / Tape &amp; Reel</td>
</tr>
<tr>
<td>LB11867FV–TLM–H</td>
<td>SSOP16 (225mil) (Pb–Free / Halogen Free)</td>
<td>Au–wire</td>
<td>2,000 / Tape &amp; Reel</td>
</tr>
<tr>
<td>LB11867FV–W–AH</td>
<td>SSOP16 (225mil) (Pb–Free / Halogen Free)</td>
<td>Cu–wire</td>
<td>2,000 / Tape &amp; Reel</td>
</tr>
</tbody>
</table>

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.
**MECHANICAL CASE OUTLINE**

**PACKAGE DIMENSIONS**

### SSOP16 (225mil)

CASE 565AM

ISSUE A

**DATE 23 OCT 2013**

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**SOLDERING FOOTPRINT**

- **Dimensions:**
  - Length: 5.80 mm
  - Width: 1.5 mm

- **Unit:** mm

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**MARKING DIAGRAM**

*This information is generic. Please refer to device data sheet for actual part marking.*

**Pb-Free indicator, “G” or microdot “G0071”, may or may not be present.**

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**NOTE:** The measurements are not to guarantee but for reference only.

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**Document Information**

- **Document Number:** 98AON66065E
- **Description:** SSOP16 (225MIL)
- **Page:** 1 of 1

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